

ORSETT BRIEFING PAPERS FOR PSYCHOLOGISTS

No.11 - Basics of the Immune System

INTRODUCTION

"The function of the immune system is recognition and defence against foreign substances, in distinguishing what is 'self' from 'non-self' ¹. It has been called a "society of interacting cells" ². Immune responses involve the central nervous system and the endocrine system as well.

Immunocompetence is the ability of the immune system to defend the body against foreign substances. This can vary due to stress, for example. Stress can produce immunosuppression, which is a reduction in the effectiveness of the immune system to defend the body.

KINDS OF IMMUNITY

There are two kinds of immunity:

i) Innate - aspects of the immune system that are present from birth; eg: skin barrier, cough reflex, wound healing and inflammation, fever (pyrexia) ³ (figure 1);

ii) Acquired - aspects that develop after birth; eg: antibody production, immune organs like the thymus (figure 2).

There will be a primary response to an antigen which is not recognised by the immune system, and after this reaction memory B cells are formed. So if the antigen reappears later, a secondary response occurs based on the memory B cells ⁴.

¹ Song & Leonard p5.

² Krammer, P (2000) CD95's deadly mission in the immune system, Nature, 12/10,789-795.

³ Gould & Brooker.

⁴ Hubbard & Mechan.

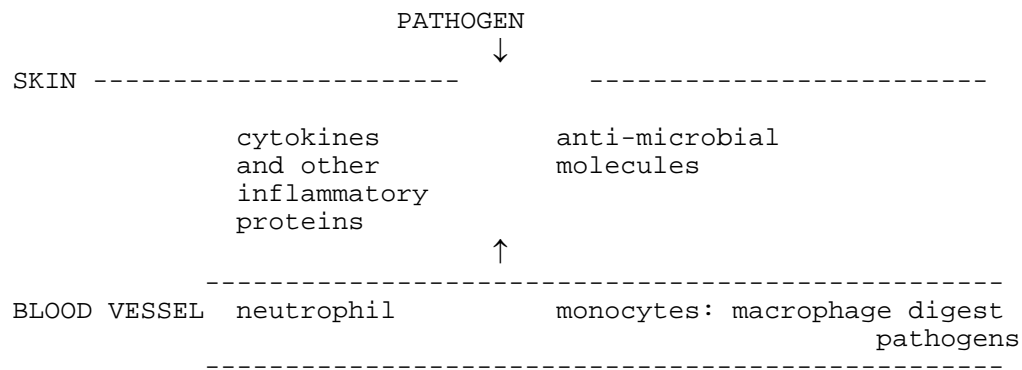


Figure 1 - Innate immune system ⁵.

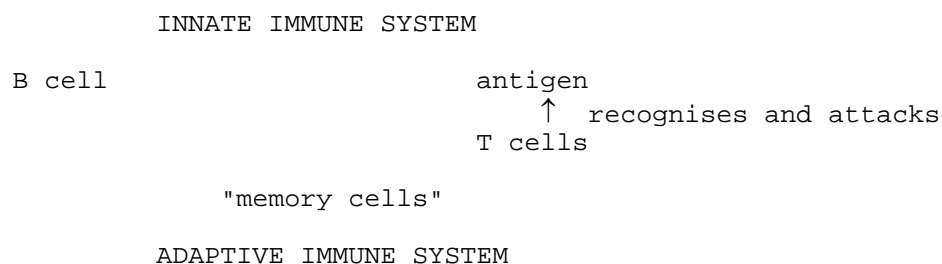


Figure 2 - Adaptive immune system ⁶.

Infections are transmitted into the human body in a number of ways, including directly through, for example, sexual intercourse, or indirectly (eg: microbes in the air).

The microbes penetrate bodily tissue and their success depends upon their number and toxigenicity (ability to produce poisons) against the body's defensive powers (ie: the immune system).

Localised infections remain at the site of entry, while focal infections both remain at the point of entry and send toxins elsewhere in the body. Systematic infections affect many areas of the body ⁷.

Exterior defences of the body include the skin barrier, and mucus at external access points to the body like the nostrils.

The immunity of the body has both non-specific and specific mechanisms. The former includes phagocytes which ingest microbes, or antimicrobial substances, like interferon. Specific immunity is based around antibodies

⁵ After O'Neill.

⁶ Ibid.

⁷ Taylor.

(proteins) (table 1) which are produced in response to stimulation by antigens. Specific immune responses also include B and T cells.

| | |
|-------------|---|
| Agglutinins | make foreign particles stick together |
| Precipitins | cause production of chemicals |
| Antitoxins | neutralise toxins |
| Lysins | break down foreign material |
| Opsomins | stimulate macrophages to engulf foreign particles |

Table 1 - Types of antibodies.

KINDS OF IMMUNE CELLS

Leucocytes, a general term for any white blood cell, are dominate in the immune system (table 2; figure 3).

| CELL TYPE | % TOTAL LEUCOCYTES |
|---------------|--------------------|
| Granulocytes | |
| Neutrophil | 40-75 |
| Eosinophil | 1-6 |
| Basophil | less than 1 |
| Agranulocytes | |
| Lymphocyte | 20-45 |
| Monocyte | 2-10 |

Table 2 - Number of different leucocytes ⁸.

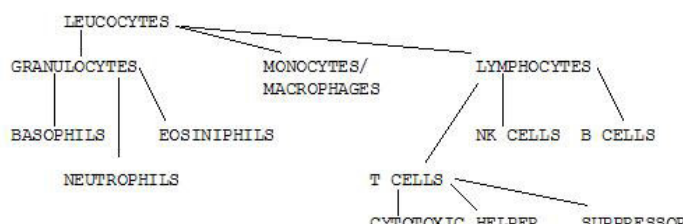


Figure 3 - Types of leucocytes ⁹.

⁸ After Evans, P; Clow, A & Hucklebridge, F (2000) Mind, Immunity and Health, London: Free Association Books.

⁹ After Hayward, S (1998) Stress, health and psychoneuroimmunology, Psychology Review, September, 16-19.

There are five major kinds of immune cells:

i) T lymphocytes - three types of cells (cytotoxic, helper, and suppressor) that recognise antigens;

ii) B lymphocytes - white blood cells from bone marrow that produce antibodies;

iii) Monocytes - leucocytes that mature into macrophages;

iv) Natural killer (NK) cells - white blood cells that attack tumours and previously unknown antigens;

v) Granulocytes - neutrophils, eosinophils, and basophils.

A fine balance of cells being produced and cells dying is maintained when antigens are not present.

IMMUNOLOGICAL REACTIONS

There are two basic immunological reactions:

i) Humoral.

B lymphocytes protect against bacteria, and B cells produce antibodies. They are best for combating bacterial or viral infections before cells are invaded;

ii) Cell-mediated.

T lymphocytes from the thymus gland produce a slower-acting response. T cells secrete chemicals that attack foreign substances, particularly those inside cells.

There are three types of T cells: cytotoxic T cells (T_c) which are toxic to foreign substances; helper T cells (T_H) which enhance T_c with chemicals like interleukin-2; and suppressor T cells (T_s) suppress the immune functions.

The key organs in the body related to the immune system are the spleen, which produces B and T cells, and removes worn-out red blood cells; the tonsils which filter out micro-organisms in the respiratory tract; and the thymus helps T cells mature, and produces the hormone thymosin which stimulates T cells.

Other key organs include bone marrow, which is the origin of all immune cells, and lymph nodes, which act as filters for the lymph system (tissue fluid).

These immune organs are divided into primary lymphoid organs (thymus and bone marrow), and secondary lymphoid organs (eg: spleen and lymph nodes) ¹⁰.

STAGES IN THE IMMUNE SYSTEM

1. Phagocytosis - white blood cells ingest microbes. Antigen-presenting cells (APC) carry antigen in form that stimulates lymphocytes;

2. Macrophages engulf antigens and release interleukin-1;

3. Helper T cells (TH) release interleukin-2 which promotes cytotoxic T cells (Tc) and suppressor T cells (Ts);

4. Latter releases chemicals to promote specific B cells;

5. Macrophages and NK cells secrete interferon, which inhibits viral reproduction in uninfected cells;

6. Macrophages, NK cells and TC directly kill infected cells;

7. TS turns off immune response as appropriate ¹¹.

Wound healing has the following stages:

i) Inflammatory stage - vasoconstriction (reduced blood to wound site) and blood coagulation;

ii) Platelet activation, and release of growth factors which stimulate migration of phagocytes to wound site;

iii) Replication of cells for tissue regeneration and capillary regrowth.

¹⁰ Lydyard, P & Grossi, C (1993) The lymphoid system. In Roitt et al.

¹¹ Taylor.

MALFUNCTIONING IMMUNE SYSTEM

The immune system can malfunction in three ways ¹²:

i) Autoimmunity - mistakenly recognises own tissue as antigen and attacks; eg: rheumatoid arthritis;

ii) Immunodeficiency - part of immune system not able to fight infection; eg: acquired immunodeficiency syndrome (AIDS);

iii) Hypersensitivity - over-reaction of immune system relative to danger of antigen; eg: hay fever response to pollen grain.

GLOSSARY

| | |
|-------------------------|--|
| Antibody | Protein produced in response to antigen by B cells; also known as immunoglobulins (Igs), and attack antigen |
| Antigen | Foreign substance (microbes, bacteria, viruses, fungi, parasites) (or "non-self") recognised by B or T cells and that stimulates the immune system |
| B cells/ lymphocytes | White blood cells from bone marrow that produce antibodies |
| Basophil | White blood cell that contains hormones (eg: histamine) released in inflammation |
| Cytokine | Chemical messenger within immune system eg: interleukins |
| Eosinophil | Type of white blood cell; specific role in combating parasitic worms |
| Immunoglobulins (Igs) | Any protein with antibody activity: 5 different types - G, A, M, D, E; most important = IgG |
| Interferon | Antimicrobial protein that limits spread of viral infections to healthy cells |
| Interleukin | Regulate immune cell growth and function eg: interleukin-2 (IL2); 18 different types ¹³ |
| Leucocytes | General term for any white blood cell |
| Lymphocytes | Immune cells programmed to recognise specific antigens and respond; main = T and B cells |
| Macrophages | Immune cells that digest foreign substances (mature monocytes) |

¹² Male, D.K & Roitt, I.M (1993) Introduction to the immune system. In Riott et al.

¹³ Song and Leonard.

| | |
|---------------------------|---|
| Monocytes | Type of leucocyte; matures into macrophages |
| Natural Killer (NK) cells | White cells that attack tumours and previously unknown antigens |
| Neutrophils | White blood cells first to wound site |
| Phagocytes | White blood cells that ingest foreign particles; includes monocytes, macrophages, and neutrophils; most important type are mononuclear phagocyte cells made from bone marrow stem cells |
| Platelets | Small cell fragments that stick together to form clots where walls of blood vessels damaged |
| T cells/ lymphocytes | Type of lymphocyte which recognises antigens; three types: cytotoxic, helper, suppressor |

SOURCES

- Gould, D & Brooker, C (2000) Applied Microbiology for Nurses, Basingstoke: Macmillan
- Hubbard, J & Mechan, D (1997) The Physiology of Health and Illness with related anatomy, Cheltenham: Stanley Thornes
- Kalichman, S (1998) Understanding AIDS (2nd ed), Washington DC: American Psychological Association
- Ogden, J (2004) Health Psychology (3rd ed), Maidenhead: Open University Press
- O'Neill, L.A.J (2005) Immunity's early-warning system, Scientific American, January, 24-31
- Roitt, I.M; Brostoff, J & Male, D.K (1993) (eds) Immunology (2nd ed), St.Louis: Mosby
- Song, C & Leonard, B.E (2000) Fundamentals of Psychoneuroimmunology, Chichester: John Wiley
- Straub, R.O (2002) Health Psychology, New York: Worth
- Taylor, S (1995) Health Psychology (3rd ed), New York: McGraw-Hill

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